NEW SPECIES AND RECORDS OF VOLUTIDAE (GASTROPODA) FROM WESTERN AUSTRALIA

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Plates 31 - 33

ABSTRACT

Four new deep water species of volutid genera *Amoria*, *Notovoluta*, *Notopeplum* and *Volutoconus* are described from the central west coast of Western Australia. Another species of *Notovoluta*, previously described as a south eastern Australian Miocene fossil, is recorded living on the outer part of the continental shelf, also off the central west coast of Western Australia. The relationships and temporal and geographic distributions of all five species are discussed.

Notovoluta occidua Cotton, 1946 is removed from synonymy with *N. verconis* Tate, 1892; but *Notovoluta rossiteri* (Brazier, 1898) is considered to be a junior subjective synonym of *N. kreuslerae* Angas, 1865.

INTRODUCTION

Biological exploration of the long and varied coastline of Western Australia began in the 17th century with the visit of William Dampier to the northern shores in 1699. Subsequently many new marine species of molluscs and other animals were described by European scientists from specimens collected by British, French and German exploratory expeditions. (For a historical summary see Alexander, 1916.) Some Western Australian material has been described by conchologists of the eastern states of Australia in more recent years, but no comprehensive collection of the molluscan fauna of this large State has ever been made. It is not surprising then that recent field activity in the region has already produced a large number of undescribed species and unexpected locality records. This is especially true of the fauna from deeper water on the outer edge of the Western Australian continental shelf. Even in a family as well studied as the Volutidae many new discoveries have been made, so that in this paper it is possible to describe no less than 4 new species. More may be expected as field activities continue.

Zoogeographers studying shallow water marine faunas have shown that the central Western Australian coast from North West Cape to Cape Leeuwin is a zone of overlap between the tropical ("Indo-West Pacific") fauna of the north and the temperate ("Flindersian") fauna of the south (Kott, 1952; Wilson & Gillett, 1971). In the vicinity of Perth the shallow water molluscan fauna is composed of almost equal numbers of northern and southern species (Wilson & Hodgkin, 1967; Wilson & Gillett, 1971). My unpublished observations on the fast-growing collections of the Western Australian Museum suggest that the benthic fauna of the outer part of the continental shelf in the same region has a similar proportion of northern and southern representatives (although the species concerned are mostly different from those of the shallows). One surprise, however, is the number of deep water west coast species which have their ancestral affinities with ancient autochthonous Tertiary groups of south-eastern

Australia. In the Volutidae, the species of *Notovoluta, Notopeplum* and *Volutoconus* described here have such affinities. It is hoped that future opportunities will arise to describe other groups which have similar affinities and to discuss this matter more fully. In the meantime the following data and descriptions are given in the hope that they may stimulate and facilitate interest in the subject and in the taxonomy and zoogeography of Australian Volutidae.

The abbreviation WAM used in this paper stands for Western Australian Museum.

DESCRIPTIONS

Genus *AMORIA* Gray, 1855

1855 *Amoria* Gray, *Proc. Zool. Soc. Lond. 1855*: 64. Type species (subsequent designation, Harris, 1897): *Voluta turneri* Griffith and Pidgeon, 1834.

DISTRIBUTION: The genus is confined to the continental shelves of Australia except for two species which extend to the islands of eastern Indonesia i.e. Tanimbar, Kai and Aru (Wilson, unpublished data). A fossil species is known from Pliocene rocks of South Australia.

REMARKS: The taxonomy of the genus has been discussed in detail by Ludbrook (1953), McMichael (1964), and Weaver and du Pont (1970). The most important diagnostic characters are a smooth and glossy elongate ovate shell and smooth multispiral obtusely conical protoconch, and a uniserial radula with Y-shaped unicuspid teeth. Weaver and du Pont (1970) list 13 species as members of the subgenus *Amoria* s.s. Of these 5 are found in Queensland waters, 4 are found only in Western Australia and Northern Territory waters, 2 are common to the north west and north east coasts, and 2 (*A. jamrachi* Gray, 1864; *A. praetexta Reeve*, 1849) live on the coasts of North Western Australia, Northern Territory and the south eastern islands of Indonesia (Wilson, unpublished data).

Most of these species are confined to the tropical waters of the northern coast of the continent, although two of them, *A. grayi* Ludbrook (1953), and *A. damonii* Gray (1864), range well south into the warm temperate waters of the west coast of Western Australia. The new species described here makes the total in the subgenus 14, and is the only one confined to subtropical and temperate waters.

Amoria (Amoria) diamantina sp. nov.

Pl. 31, fig. 1-4.

Type locality: CSIRO station 208, 27°40'S, 113°20'E, west of Bluff Point, Geraldton, Western Australia, depth 130 m, associated organisms in trawl net "sponge, bryozoa, molluscs and crustacea"; bottom water temp. 19.83°C.

Type series: Holotype: Adult shell with body preserved, WAM. 142-64, taken in a beam trawl by CSIRO aboard HMAS "Diamantina", cruise DM 6/63, 10th Oct. 1963.

Paratypes: All from Western Australia and lodged in the collection of the Western Australian Museum.

WAM.N4454, piece, NNW of Rottnest I., 114 m, sponge and sand, B. R. Wilson on "Bluefin", 15.VIII.62

WAM.4685-68, adult shell, SW of Rottnest I., 146 — 154 m, B. R. Wilson on "Bluefin", 17.IX.65

WAM.663-71, adult shell, W of West End, RottnestI., 146 m, B. R. Wilson on "Bluefin", 16.IX.65

WAM.N4331, 3 pieces, NW of Rottnest I., 183 — 189 m, sponges and sand, B. R. Wilson on "Bluefin", 14.VII.62

WAM.664-71, adult shell, W of West End, Rottnest I., 178 — 183 m, B. R. Wilson on "Bluefin", 16.IX.65

WAM.665-71, juv. shell, NW of Rottnest I., 146 m, sand, bryozoa and sponge, B. R. Wilson on "Bluefin", 15.IX.65

WAM.N4356, 2 juv. shells, NW of Rottnest I., 156 m, sponge and sand, B. R. Wilson on "Bluefin", 15.VIII.62

WAM.N4303, adult shell, WNW of Rottnest I., 173 — 175 m, sponge and sand, B. R. Wilson on "Bluefin", 14.VIII.62

WAM.144-64, adult shell, W of Rottnest I., 32°00'S : 115°116'E, 137 — 142 m, with fish and shells, no sponges, bottom water temp. 17.74°C, CSIRO Stn 225, HMAS "Diamantina" cruise DM 6/63, 12.X.63

WAM.626-71, adult shell and body preserved, W of West End, Rottnest I., 178 — 185 m, B. R. Wilson on "Bluefin", 12.VIII.62

WAM.133-64, adult shell and body preserved, W of Rottnest I., 32°S : 115°16'E, 137 — 143 m, with fish and shells, no sponge, bottom water temp. 17.34°C, CSIRO Stn 225, HMAS "Diamantina" cruise DM 6/63, 12.X.63

WAM.666-71, adult shell, NW of Green I., 30°38'S : 114°46'E, 146 m, CSIRO Stn 41, HMAS "Diamantina" cruise DM 1/70, 27.XI.70

WAM.141-64, adult shell and body preserved, W of Dirk Hartogs I., 25°31'S : 112°20'E, 133 m, bottom water temp. 19.52°C, CSIRO Stn 200, HMAS "Diamantina" cruise DM 6/63, 9.X.63

WAM.147-64 and 148-64, 3 juv. and 2 adult shells, W of N.W. Cape, 21°49'S : 113°56'E, 122 — 128 m, bottom water temp. 23.18°C, CSIRO Stn 24, HMAS "Diamantina" cruise DM 1/64, 1.II.64.

Distribution: At depths from 119-188 metres between North West Cape and Rottnest Island, Western Australia (between latitudes 21°48'S and 32°S).

Description of the holotype shell: Shell elongate-ovate; spire of moderate height (ratio spire height to total height 0.27), conical, with a blunt apex; protoconch of 4 smooth glossy whorls with slightly convex sides; teleoconch of $2\frac{1}{2}$ smooth glossy whorls; sutures narrow and very shallow; outerlip rather straight, strong and slightly thickened; aperture elongate and rather narrow; anterior siphon canal rather narrow, deep, U-shaped and only slightly oblique; parietal wall and columella almost straight, columella with 4 strong flat-topped oblique plaits; anterior fasciole very low but well defined by change of pattern of the growth lines and demarcated by a weak obliquely spiral ridge which is a continuation of the most posterior columellar plait, similar weak obliquely spiral ridges on the fasciole represent continuations of the second and third columellar plaits; protoconch whorls pale pink to grey with a faint whitish line in the sutures; teleoconch whorls light apricot (pink) with a spiral row of small distinct V-shaped brown marks in the sutures, a pale brown spiral band immediately behind the sutures, and two central spiral bands of short thin, rather straight brown lines around the body whorl; interior white. Measurements: total shell height 55.2 mm, spire height 14.6 mm, width 22.0 mm.

Variations of shell characters: There is little variation in the paratypic series. Colour and markings are quite consistent except for a few cases where some adjacent axial lines coalesce. Data on measurements and number of whorls for the type series of the new species and for *A. grayi* are given in Table 2.

Anatomy: The radula and soft parts of the holotype remain intact and have not been examined. Nor have detailed anatomical notes on the preserved paratypes been attempted. The preserved specimens in the paratype series have all faded and little colour remains. From colour slides of living specimens it is evident that the pattern is very like that of *A. grayi*, i.e. ground colour cream or pinkish with radial red lines on the

foot and transverse red bands around the siphon and eye stalks. But the lines and bands in *A. diamantina* are much narrower than they are in *A. grayi.*

Radula (of paratype WAM.626-71): Uniserial with Y-shaped teeth. No significant differences were observed between this radula (Fig. 1-E) and one taken from a specimen of *A. grayi* (WAM.625-71). (See also the figure of an *A. grayi* radula in Weaver and du Pont, 1970, p. 153, Fig. 34.)

Differential diagnosis: The shape of the nucleus, number of protoconch whorls, and colour pattern of the body whorl are the most useful characters differentiating between *A. diamantina* and its sympatric congeners *A. grayi* Ludbrook, 1953 and *A. damonii* Gray, 1864 (Table 1).

TABLE 1.

Diagnostic characters of *A. diamantina, A. grayi* and *A. damonii.*

Species	Nucleus	Body whorl colour and pattern
A. diamantina	blunt	Uniformly pale apricot except for two spiral zones of short, thin, rather straight, regularly spaced, brown axial lines.
A. grayi	pointed	Ground colour variable, cream, white, buff or dun, sometimes with two central brown spiral bands, axial lines when present zig-zag, irregularly spaced, and not confined within the spiral bands in adults.
A. damonii	blunt	Ground colour variable, pink, ivory, cream, white or fawn, with a pattern of reticulate chocolate or chestnut brown lines and usually two central spiral zones of blotches or crowded reticulate lines.

Remarks: This new species has the large, smooth, and conical protoconch of the subgenus *Amoria* s.s. Two other species of this group, *A. grayi* and *A. damonii,* live in the same region of the Western Australian coast as the new species although both have a much wider range than *A. diamantina. A. grayi* extends from Geographe Bay in the south west of Western Australia to Cambridge Gulf, Northern Territory (Weaver & du Pont, 1970: 154). In past times this species reached as far east as South Australia, for it is recorded from Pliocene fossil beds in that State (Ludbrook, 1958: 75-76) thus representing a significant penetration of

PLATE 31.

Fig. 1. *Amoria diamantina* sp. nov. Holotype; WAM.142-64, west of Bluff Point, Geraldton, W.A., 146 m.

Fig. 2-4. *Amoria diamantina* sp. nov. Paratype; WAM.4685-68, southwest of Rottnest I., W.A., 146-154 m.

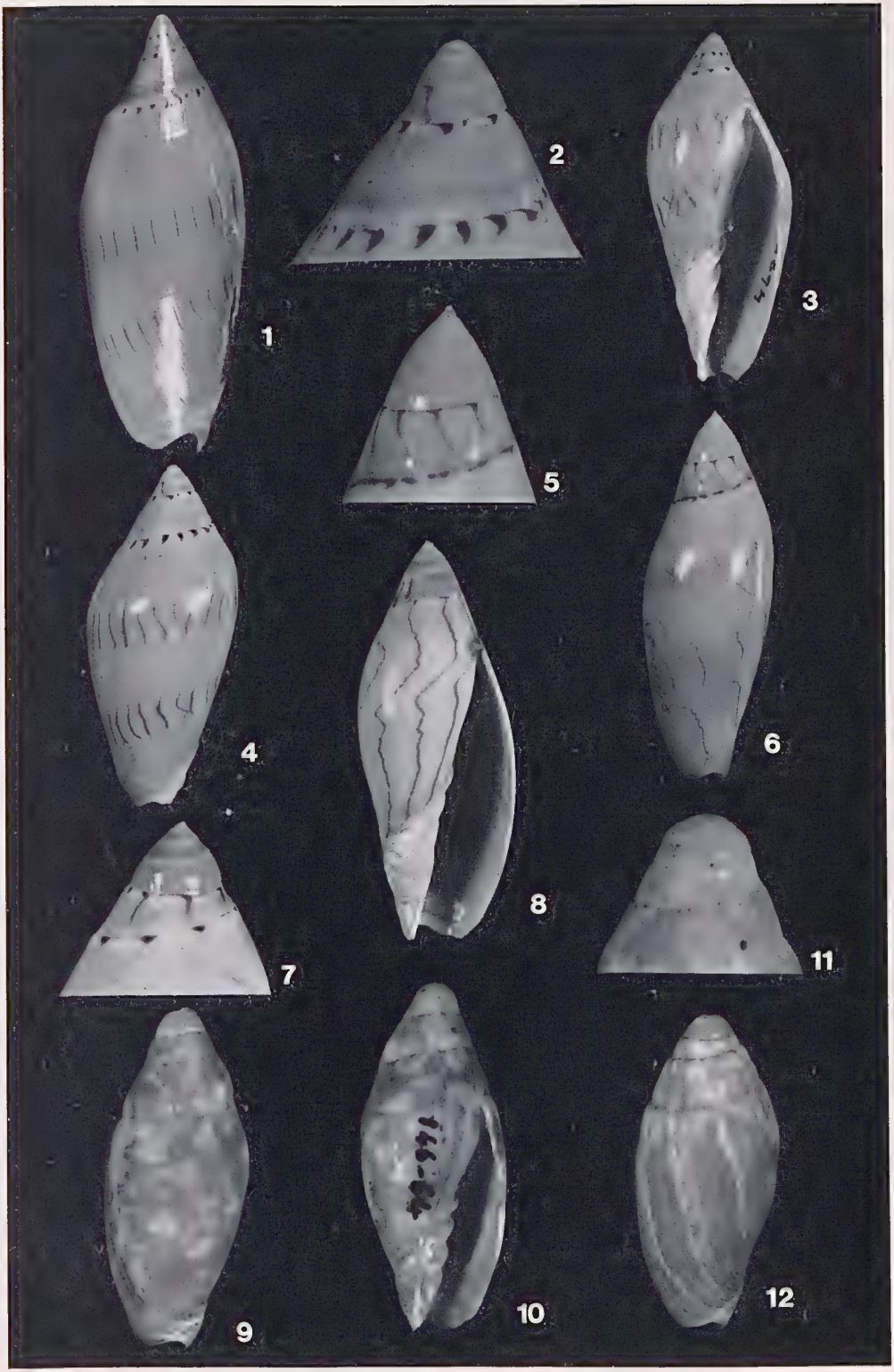
Fig. 5-6. *Amoria grayi* Ludbrook, 1953; WAM.649-71, northwest of Rottnest I., W.A., 146 m.

Fig. 7-8. *Amoria grayi* Ludbrook, 1953; WAM.658-71, Rosemary I., Dampier Archipelago, W.A., intertidal.

Fig. 9-11. *Volutoconus capricorneus* sp. nov. Holotype; WAM.146-64, west of Point Cloates, W.A., 133 m.

Fig. 12. *Volutoconus capricorneus* sp. nov. Paratype; WAM.774-71, west of Point Cloates, W.A., 133 m.

Whole shells approximately x 1½, spires approximately x 3.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a tropical northern species into southern Australian waters. *A. damonii* ranges from Fremantle, Western Australia to North Queensland.

A. diamantina tends to occupy a different depth zone to *A. damonii* and *A. grayi* which live in relatively shallow water, even on intertidal sand flats, and rarely occur below 128 metres. *A. diamantina* appears to be confined to the outer part of the continental shelf, 114 metres being the shallowest record.

A. damonii is a variable species (Weaver & du Pont, 1970: 151-152), but the colour patterns of the species are characteristic and the shells cannot be confused with *A. diamantina.* The nucleus of *A. damonii* is blunt like that of *A. diamantina,* but the protoconch is much larger and consists of about 5 whorls.

A. grayi is also a variable species, especially in shell coloration. For some time it was considered hat *A. diamantina* might be only a deepwater ecomorph of *A. grayi,* but this was difficult to reconcile with the consistency of the colour pattern and protoconch characters, the absence of intermediate forms in intermediate depths, and the wide distribution of the deepwater form from North West Cape to Rottnest Island. Doubts were dispelled by the discovery of two specimens of typical *A. grayi* within the depth zone of *A. diamantina,* one of these (WAM 649-71, Pl. 31, figs. 5-6) taken in the same dredge haul as a typical *A. diamantina* (WAM 665-71). It is now confidently concluded that *A. grayi* and *A. diamantina* are two very closely related but distinct species generally occupying different depth zones on the mid western continental shelf, but occasionally occurring together in the 114 to 146 metre zone.

The two primary characters which differentiate between *A. diamantina* and *A. grayi,* i.e. the shape of the protoconch nucleus and the colour and markings on the body whorl, are summarized in the differential diagnosis.

In *A. diamantina* the protoconch is conical but blunt at the apex like most other species of the genus. *A. grayi* is exceptional in that the protoconch terminates in a sharp, pointed apex. This character is quite consistent. There also tend to be slightly fewer protoconch whorls in *A. diamantina* (Table 2).

The ground colour of the teleoconch whorls varies in *A. grayi* (Table 1). While adults in northern populations tend to have rather uniformly coloured shells, southern specimens (from the Fremantle and Geographe Bay areas) consistently have two wide spiral brown bands (Pl. 31, fig. 6). In juvenile specimens throughout the species range there are usually wavy axial brown lines (Pl. 31, fig. 8) and, in southern juvenile specimens, these may be broken with irregular axial lines concentrated within the two spiral brown bands (Pl. 31, fig. 6). But such axial markings rarely persist on the adult body whorl and when they do they are sparse and irregular. In *A. diamantina* the body whorl is always uniformly apricot pink with two spiral zones of short, rather straight and regularly spaced brown axial lines.

Other differentiating characters are less consistent. The brown V-shaped sutural marks tend to be distinct and regular in *A. diamantina* and often indistinct and irregular in *A. grayi.* The light brown subsutural band on the teleoconch whorls is usually strongly developed in *A. grayi* but always very weak in *A. diamantina.*

TABLE 2.
Comparison of meristic data for *A. grayi* and *A. diamantina*.

	Total Shell Height (adult)		Total no. of whorls (adult)	No. Proto-conch whorls	Spire height / Total height		Protoconch height	
	Mean cm	Range cm			Mean	Range	Mean cm	Range cm
A. grayi								
(a) Maud Landing populations (10 specimens)	4.78	4.50-5.70	6-6½	4-4¼	0.27	0.22-0.32	0.53	0.41-0.66
(b) Other populations (15 specimens)	7.42	6.25-8.88	6-7	4-4½	0.27	0.25-0.29	0.71	0.56-0.81
A. diamantina (16 specimens)	4.66	3.78-5.51	5½-6¼	3½-4	0.27	0.26-0.29	0.45	0.35-0.49

A summary of meristic data for these two species is given in Table 2. In the Maud Landing area, about 120 miles north of Carnarvon, specimens of *A. grayi are* "dwarf" (see also Weaver & du Pont, 1970: 154) and it is convenient for these to be considered separately when making comparisons with *A. diamantina*. The adult size range of the new species is comparable to that of the Maud Landing *A. grayi* dwarfs.

Protoconch height in *A. diamantina* throughout its whole geographic range is considerably less than that of *A. grayi* throughout its range, with the exception of the abnormal Maud Landing *A. grayi* population. The ratio of spire height to total shell height, however, is similar and consistent in the two species (Table 2).

There is no other described species of *Amoria* with which *A. diamantina* may be confused (see descriptions and illustrations in Weaver & du Pont, 1970.) I am pleased to name the new species after HMAS "Diamantina," the vessel responsible for securing a great amount of new and interesting material from the outer part of the Western Australian continental shelf.

Abbreviated list of *A. grayi* specimens examined and compared with the new species (only adult shells used for measurements):

WAM.N1986, Busselton; WAM.N1950, Busselton; WAM.N2338, Dunsborough; WAM.N2339, Quindalup; WAM.N4190, off Garden I., 18 m; WAM.9857 and 122-65/7, Cottesloe; WAM.647-71, Kwinana, Cockburn Sound; WAM.43-60, Jervoise Groyne, Cockburn Sound, 5.5 m; WAM.648-71, NE of Rottnest I., 36 m; WAM.N4418, piece, NW of Rottnest I., 155-163 m; WAM.649-71, NW of Rottnest I., 146 m; WAM. 651-71, Cervantes I., 110 m; WAM.625-71, 9 preserved specimens, radula examined, 22 ml N of Maud Landing, intertidal; WAM.653-71, 10 shells, 1 ml S of Maud Landing, intertidal; WAM.145-64, W of Pt Cloates, 129 m; WAM.812-71, Thevenard I., intertidal; WAM.658-71 and 659-71, Rosemary I., intertidal; WAM.1-61, off Delambre I., 37 m; WAM.811-71, Port Hedland, intertidal; WAM.662-71, Broome, intertidal.

Genus *VOLUTOCONUS* Crosse, 1871

1871 *Voluta (Volutoconus)* Crosse, *J. de Conch.* (3), *19*: 306. Type species (by monotypy) *Voluta coniformis* Cox, 1871.

Distribution: Living species occur in Northern Australia from about latitude 31°S in Western Australia to Port Macquarie in N.S.W., the islands of south eastern Indonesia, and the south coasts of West Irian and Papua. Two fossil (Miocene) species considered to belong to this genus occur in Victoria.

Remarks: Shells of the four described living species are moderately large, solid, with 4 or more strong columellar plaits. The most characteristic feature is a small spine-like structure called a "calcarella" on the protoconch. The radula, where known, is uniserial with large tricuspid teeth on which cusps are strongly arched (Abbott, 1958, Figs. 1-2). Sculpture and spire height vary between the species.

For a full account of the genus see Weaver and du Pont (1970: 133-138, pls. 61-62), and Wilson and Gillett (1971: 134-136, pls. 89-90).

Tate (1888) described two Miocene fossil volutes from Victoria and suggested that they may be the ancestors of modern *Volutoconus*. Finlay (1930: 44) and Darragh (1970: 178, 191) have since used that generic name for them. The two species are now known as *Volutoconus limbata* (Tate, 1888) and *Volutoconus ralphi* Finlay, 1930 (=*Voluta conoidea* Tate, 1888). Both are small species which lack a protoconch calcarella and their relationship to the modern *Volutoconus* species rests on their similarity in shape, columella, and solidarity.

The new species described here is provisionally assigned to *Volutoconus*, mainly because of its close resemblance to the fossil "ancestral" species.

Volutoconus capricorneus sp. nov.

Pl. 31, fig. 9 - 12

Type locality: CSIRO station 17; 22°59'S : 113°25'E; W of Point Cloates, W.A.; 133 m; associated organisms "sponges, crabs, etc.", bottom water temp. 21.88°C.

Type series: Two "dead" shell specimens taken in the same beam trawl haul by CSIRO aboard HMAS "Diamantina" cruise DM 1/64, 31st Jan. 1964. HOLOTYPE WAM. 146-64; PARATYPE WAM. 774-71.

Description of the holotype: Shell small, unusually solid, elongate-ovate, with 4 protoconch and 3 teleoconch whorls. Spire rather high (ratio spire height to total shell height 0.38); protoconch smooth large dome-shaped with a central nucleus; sutures well defined but not deeply indented. Teleoconch whorls rounded with only weakly developed shoulders; first teleoconch whorl with very weak axial folds, penultimate whorl with 11 low axial folds which tend to form weak nodules at the shoulder, body whorl with 5 weak axial folds at the shoulder on the ventral and left sides but lacking these on the dorsal and right sides; teleoconch whorls smooth except for fine growth lines and minute wavy spiral striae. Aperture narrow, elongate-elliptical; anterior canal moderately broad and deep, oblique, U-shaped; anterior fasciole short and low but well developed; columella calloused, with 4 strong, oblique plaits, of

which the first and second are stout rounded and the third and last are rather more angulate and narrow; a prominent spiral cord on the parietal wall may represent a fifth columellar plait. Protoconch cream, teleoconch pale orange with numerous tent-shaped pinkish white markings of varing size, with a few thin short wispy orange-brown lines on the sutural ramp of the body whorl arising from the sutures, columella tawny, especially at the anterior end, columellar plaits white, deep interior pinkish white becoming pale orange toward the lip and tawny toward the anterior end.

Measurements:

	Total Shell Height	Spire Height	Width
Holotype (WAM. 146-64)	3.72 cm	1.43 cm	1.60 cm
Paratype (WAM. 774-71)	3.42 cm	1.12 cm	1.56 cm

Paratype: The single paratype resembles the holotype except for the following small differences. It has only $6\frac{1}{2}$ whorls, the spire is lower (spire height : total shell height ratio 0.33), and there is a shallow sulcus around the sutural ramp of the body and penultimate whorls making the shoulders slightly more pronounced. The wispy sutural lines and axial folds on the teleoconch whorls are rather more numerous than in the holotype.

Remarks: At first glance the type specimens might be taken for juvenile *V. hargreavesi* (Angas, 1872) or *V. coniformis* (Cox, 1871). The known geographic range of *V. hargreavesi* is from Wedge Island to the Dampier Archipelago, Western Australia and the type locality of the new species lies within this range. *V. coniformis* is found further north (Nickol Bay to Broome). Both species are much larger than *V. capricorneus*, minimum recorded shell height of adults being 6 cm in *V. coniformis* and 7.5 cm in *V. hargreavesi*. The protoconch is much smaller in *V. capricorneus* although the number of protoconch whorls is about 4 in all three species. A calcarella is usually prominent in *V. hargreavesi*, very small in *V. coniformis*, and absent in *V. capricorneus*. The protoconch is smooth in *V. capricorneus*, smooth or axially lirate in *V. hargreavesi*, and axially lirate in *V. coniformis*. The teleoconch whorls are weakly axially lirate and spirally striate in *V. capricorneus*, smooth or axially lirate in *V. hargreavesi*, and very finely striate both axially and spirally in *V. coniformis*.

Apart from these differences the shell characters of the new species match those of the Recent species of *Volutoconus* quite well, but because of the lack of a calcarella its assignment to that genus must remain provisional. Lack of a calcarella in the two similarly small Miocene species *V. ralphi* and *V. limbata* lends support to the placement of *V. capricorneus* in *Volutoconus*, although the generic position of all three species may well be questioned. Study of the soft parts of *V. capricorneus* may do much to resolve this matter when living specimens are discovered.

The specific name of this new species alludes to the proximity of the type locality to the Tropic of Capricorn.

Genus *NOTOVOLUTA* Cotton, 1946

1946 *Notovoluta* Cotton, *S. Aust. Nat.* 24 (1): 15. Type species (by original designation.): *Voluta kreuslerae* Angas, 1865.

Distribution: Living on the continental shelf of southern Australia from Victoria and South Australia to the south coast of Western Australia,

and here also recorded from the mid west coast of Western Australia as far north as Geraldton. Fossil species known from the Miocene of Victoria.

Remarks: The original diagnosis of *Notovoluta* given by Cotton (1946: 15-16) and the slightly amplified version given by Weaver and du Pont (1970: 167-168) are adequate to characterize the genus. The most useful diagsostic characters are the high spire with a smooth, dome-shaped ("papilliform") protoconch and axially plicate early teleoconch whorls, and the 4 strong, oblique, columellar plaits.

In addition to the type species, Cotton (1946) included the Victorian species *rossiteri* Brazier, 1898, the South Australian species *verconis* Tate, 1892 and the Western Australian species *occidua* Cotton, 1946 in the genus *Notovoluta*. Subsequently, Cotton (1949, 1957) added the Queensland and south west Pacific species *thatcheri* McCoy, 1868 and *perplicata* Hedley, 1902 but Weaver and du Pont (1970) pointed to the small, radially ribbed, conical protoconchs and the numerous columellar plaits of these tropical species and concluded that they are not congeneric with the southern Australian species of *Notovoluta*. This conclusion seems reasonable, although the relocation of *perplicata* and *thatcheri* to *Cymbiolacca* Iredale, 1929 may need further consideration. Weaver and du Pont (1970) accept *rossiteri* as a distinct species but the unique holotype is certainly only a large specimen of *N. kreuslerae*.

For comparison with the species described and recorded here the protoconchs and early teleoconch whorls of *thatcheri, kreuslerae, verconis* and *occidua* are illustrated (Pl. 32).

Weaver and du Pont (1970) placed *occidua* into the synonymy of *verconis* on the grounds that "the only apparent differences between it and the more easterly *Notovoluta verconis* are that the shell is somewhat narrower with a longer spire". After examination of the holotype (Pl. 32, Figs. 8-9) I disagree with that opinion for, in addition to these differences, the type has strong axial costae, a smaller protoconch, and lacks the angulate shoulders characteristic of *verconis*. *Notovoluta occidua* seems to be closely related to *N. pseudolirata* and may later prove to be a subspecies of it. *Notovoluta occidua* is known from 64 metres off Hopetoun (type locality) and 137-183 metres west of Eucla (Verco, 1912: 224), both localities on the south coast of Western Australia.

Several Tertiary fossil species of *Notovoluta* are known. Two of them, *pseudolirata* Tate, 1888, and *cathedralis* Tate, 1888 occur in the Middle Miocene (Balcombian) of Victoria. A third Victorian Miocene fossil species, *sarissa* Tate, 1889, is sometimes referred to *Notovoluta* but it has a large conical protoconch and Darragh (1970: 193) placed this species in *Alcithoe*. Another fossil species of *Notovoluta*, as yet undescribed, occurs in the rich early Pleistocene shell beds of the Roe Plain on the south east coast of Western Australia (pers. comm. Dr N. H. Ludbrook).

The discovery of *N. pseudolirata* and the related new species of *Notovoluta* living off the central west coast of Western Australia considerably extends the known distribution of the genus. The survival of *N. pseudolirata* from the Miocene to the present is also of great interest.

Volutidae

Notovoluta pseudolirata Tate, 1888

Pl. 32, fig. 4 - 7.

1888 *Voluta pseudo-lirata* Tate, *Trans. R. Soc. S. Aust.*, 10: 176, pl. 13, fig. 6; 1889, *ibid.*, 11: 131.

Type locality: "lower beds at Muddy Creek", Victoria (Middle Miocene). Holotype: South Australian Museum, Adelaide, Tate Collection (ex Geology Department, University of Adelaide) regn no. T 608 specimen C.

Description: Shell rather solid, elongate, fusiformly cylindrical. Protoconch dome-shaped with $2\frac{1}{2}$ smooth whorls and a central nucleus; teleoconch of 5 whorls. Sutures prominent but not deeply excavated. Spire height about or slightly less than half the total shell height. Anterior fasciole usually weak, anterior canal short, moderately broad and shallow, oblique. Aperture narrow, outer lip sharp, slightly patulous anteriorly, elliptical; columella nearly straight, bearing 4 strong, vertical plaits which cross the columella at a slight angle, the anterior plait is the smallest of the 4; there may be an additional spiral cord or very weak 5th plait posteriorly on the parietal wall. First to fourth teleoconch whorls with convex sides, ornamented with strong axial costae, 18-21 on the first teleoconch whorl, 17-23 on the on the second, 13-18 on the third, and 11-14 on the fourth; body whorl with up to 12 axially elongate angular nodules or short axial costae at the shoulders or on the posterior 1/3 of the whorl excluding the sutural ramp (nodules sometimes confined to the ventral and left sides of the body whorl). External surface smooth except for minute spiral striae, glossy, cream with a pale pink or orange band around the sutural ramp, a spiral row of small orange-brown spots in the sutures, usually another spiral row of orange-brown spots just anterior to the centre of the body whorl, and sometimes two wide spiral bands of very faint orange-brown reticulate markings. There is a tiny light brown spot at the nucleus of the protoconch. Interior cream.

Measurements:

	Total height cm	Width cm	Spire height cm	Spire height / Total height
WAM.131-64	5.98	2.06	2.90	0.49
WAM.130-64	6.14	2.22	3.08	0.50
WAM.471-71 (juv.)	4.55	1.60	2.22	0.48
WAM.470-71	5.40	1.91	2.37	0.44

Fossil records: Middle Miocene (Balcombian) at Muddy Creek, Hamilton, and Schnapper Point, Mornington, Victoria.

Recent records:

WAM.130-64 (1 adult shell) and WAM.131-64 (1 adult shell), beau trawl 137—143 m, west of Rottnest I., Western Australia, lat. 32°00'S, long. 115°16'E, CSIRO Cruise DM 6/63, HMAS "Diamantina", stn 225, 12.X.63; WAM.471-71 (1 whole juv., 1 piece adult), dredged, 146 m, sand/bryozoa/sponge, North West of Rottnest I., Western Australia, B. R. Wilson on "Bluefin", 15.IX.65; WAM.N4351 (1 spire of juv.) dredged, 156 m, sand and sponges, North West of Rottnest I., Western Australia, B. R. Wilson on "Bluefin", 15.VIII.62; WAM.N4259 (1 broken piece), dredged 200 — 214 m, sand and sponge, North West of Rottnest I., Western Australia, B. R. Wilson on "Bluefin", 14.VIII.62; WAM.N4192 (4 broken pieces), dredged at various depths 146 — 189 m, N.N. West of Rottnest I., Western Australia, B. R. Wilson, 14.VIII.62; WAM.470-71 (1 whole adult shell), dredged, 146 m, sand/sponge/bryozoa, North West of Rottnest I., Western Australia, B. R. Wilson on "Bluefin", 15.IX.65.

Remarks: The number of axial costae on the early teleoconch whorls and the development of nodules or short costae on the body whorls are rather variable in this species. Also there is some variation in the development of the anterior fasciole. In one Rottnest I. specimen (Pl. 32, Fig. 7, WAM 470-71) the anterior fasciole is quite strong, the spire is relatively

low, and the shell is more cylindrical than fusiform, although in other characters it fits the rest of the Recent series.

Use of the name *pseudolirata* Tate, 1888 for these Recent specimens from the outer part of the western continental shelf may be regarded as dubious by some in view of the 12 million years and 2 thousand miles which separate them from the type material. But, having compared the Western Australian Recent series with fossil material in the National Museum of Victoria, I can find no morphological characters by which they can be differentiated. Since neither temporal nor geographical distance is an acceptable taxonomic character there is no alternative but to consider the fossil and Recent specimens conspecific.

The facies of the type locality is that of a deepwater muddy or silty environment (Mr T. A. Darragh, pers. comm.). The habitat from which the Recent specimens were taken is similar depthwise although the substrate consists of fine sand. The fact that *N. pseudolirata* is not recorded from Pliocene or Pleistocene shell beds may be because most southern Australian shell beds of those periods represent shallow water facies. More curious is the apparent absence of the species at the present time from the outer continental shelf of the southern Australian coast where considerable dredging has been done by Sir Joseph Verco and others. Future dredging in that region may yet prove the presence of the species there but the indications so far are that, some time since the Miocene, *N. pseudolirata* has become restricted to the outer continental shelf off the mid west coast of Western Australia.

The nearest fossil relative of *N. pseudolirata* is *N. cathedralis* Tate, 1888 which is also found in the lower beds at Muddy Creek. It is more slender than *N. pseudolirata,* the posterior slope is spirally lined and the whorls bear tubercles not costae at the shoulders.

Of the living species of *Notovoluta,* the nearest relative of *N. pseudolirata* may be the new species *N. baconi* which lives in similar depths a little further north. Distinguishing characters are given in the discussion of *N. baconi.* Another close relative is *N. kreuslerae.* That species has similar markings including sutural spots and a tiny spot on the protoconch nucleus, but the shell is much larger, broader, with a strongly developed anterior fasciole and angulate shoulders bearing prominent pointed nodules, and the axial costae on the early teleoconch whorls are poorly developed (Pl. 32, fig. 13). The south coast species *N. occidua* is also similar but may be distinguished by the even narrower shell, very strong axial costae, and smaller protoconch (Pl. 32, fig. 8-9). Further study may show that *N. occidua* is merely a southern subspecies of *N. pseudolirata. N. verconis* from South Australia is quite distinctive for it has a rather small, stout, fusiform shell with broad angulate shoulders, heavy shoulder nodules, and a small protoconch (Pl. 32, fig. 10). It may be noted that the faint reticulate pattern on *N. pseudolirata* is very like that of *N. ver-*

PLATE 32.

Fig. 1-3. *Notovoluta baconi* sp. nov. Holotype; WAM.1565-70, west of Wedge I., W.A., 128-146 m.

Fig. 4-6. *Notovoluta pseudolirata* Tate, 1888; WAM.131-64, west of Rottnest I., W.A., 137-143 m.

Fig. 7. *Notovoluta pseudolirata* Tate, 1888; WAM.470-71, northwest of Rottnest I., W.A., 146 m.

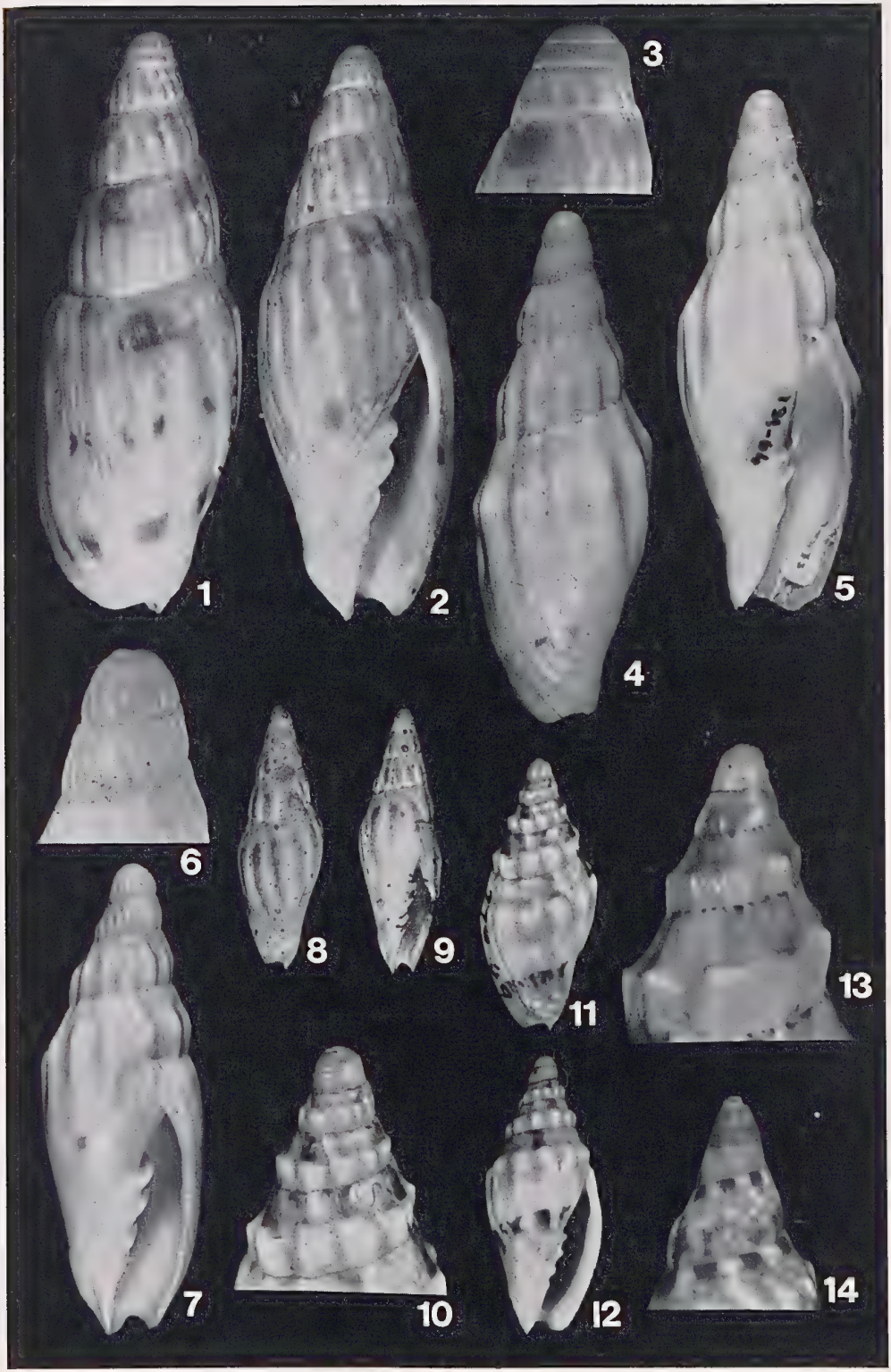
Fig. 8-9. *Notovoluta occidua* Cotton, 1946, Holotype, South Australian Museum Reg. No. D 14500, Hopetoun, 54 m.

Fig. 10-12 *Notovoluta verconis* Tate, 1892; WAM.776-69, Yankalilla Bay, St Vincent's Gulf, S.A., 24 m.

Fig. 13. *Notovoluta kreuslerae* Angas, 1865; South Australian Museum Reg. No. D 440, Backstairs Passage, S.A.

Fig. 14. *Cymbiolacca thatcheri* McCoy, 1868; WAM.786-71, Bampton Reef, Qld.

Whole shells and Figures 13-14 approximately x 1½, spires approximately x 4.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conis, although the latter species lacks sutural spots and the brown spot on the protoconch nucleus.

Notovoluta baconi sp. nov.

Pl. 32, fig. 1 - 3.

Type locality: 128-146 m west of Wedge Island, Western Australia (approx. lat. 30°50'S, long. 114°55'E).

Type series: Holotype: A whole but "dead" shell taken from a rock lobster pot by Mr Al Bacon; now in the collection of the Western Australian Museum, WAM.1565-70.

Paratype: A single broken paratype dredged by the Hawaiian-W.A. Expedition, 146 m, 10 miles N.W. Zeewyck Channel, Houtman Abrolhos [Islands], Western Australia, May 12, 1960; WAM.41-60.

Description of the holotype: Shell solid, elongate, fusiform to cylindrical. Protoconch dome-shaped and broad, smooth, consisting of $2\frac{1}{2}$ whorls. Spire height slightly less than half the total shell height. Teleoconch consisting of 5 axially plicate whorls including the body whorl, plicae on first teleoconch whorl too indistinct to be counted, 14 plicae on second teleoconch whorl, 18 on the third, 19 on the fourth and 12 plus on the body whorl; axial plicae on the ventral and left sides of the body whorl strong and extend as far anteriorly as the columellar callus, those on the right side near the lip are weak and indistinct; body whorl with numerous axial plicae on the ventral and left sides extending as far anteriorly as the columellar callus, plicae much reduced on the right side near the lip. Whorls slightly convex, lacking shoulders. Aperture elongate, broad anteriorly, narrowing to an acute angle posteriorly; lip sharp-edged, slightly patulate anteriorly. Anterior canal rather deep, broad and obliquely U-shaped; anterior fasciole moderately broad and strong. Columella almost straight, bearing 4 thick and high oblique plaits of which the first (most anterior) is the smallest and the third and fourth the largest, an additional thin oblique spiral cord present on the parietal wall may represent a fifth plait. Exterior cream with a few small and faint orange-brown spots in the sutures, a spiral band of large orange-brown squarish blotches around the sutural ramps of all the teleoconch whorls, a spiral band of similar blotches around the anterior part of the body whorl, and a spiral band of small irregular orange-brown blotches around the centre of the body whorl; interior white.

Variations: The single paratype is a broken specimen lacking most of the body whorl. The axial plicae on the first teleoconch whorl are too indistinct to be counted, there are 15 on the second teleoconch whorl, 16 on the third, 15 on the fourth, 12 plus on the body whorl. Colour pattern like that of the holotype. Columellar plaits like those of the holotype, except for the parietal cord which is much stronger.

Measurements:

	Total height mm	Width mm	Spire height mm	Spire height / Total height
Holotype WAM.1565-70	63.9	22.9	30.3	0.48
Paratype WAM. 41-60	—	—	29.4	—

Records: As only the two specimens of the type series are known, the range lies between about latitudes 29° and 31° South, at depths from 128 — 146 m.

Remarks: The shell is rather more solid than that of *N. pseudolirata*, the sides of the whorls are straighter, the columellar plaits thicker, the anterior fasciole much stronger, and the axial costae are longer and less nodulose, especially on the body whorl. The axial costae are less numerous on the first and second teleoconch whorls of *N. baconi* than in *N. pseudolirata*, but more numerous on the third and fourth whorls, and on the ventral and right sides of the body whorl. In the two specimens available for study there is no trace of reticulate patterns on the external surface. The spiral bands of large squarish blotches on the sutural ramp and around the anterior part of the body whorl, and the central band of spots, also serve to distinguish this species from *N. pseudolirata*.

The only other Recent species which resembles *N. baconi* is the south coast *N. occidua*. That species is much narrower and has a small protoconch (Pl. 32, fig. 8-9). Although it has strong and long axial costae they are less numerous than in *N. baconi*.

Although there are only two "dead" specimens of *N. baconi* known to me, they are sufficient to demonstrate that they represent a hitherto undescribed species. Of considerable interest for the future will be the determination of the geographic and depth ranges of *N. baconi* and *N. pseudolirata*. At present their known ranges do not overlap with each other, or with the ranges of other species of the genus.

The species is named after the collector Mr Al Bacon who generously donated the holotype to the Western Australian Museum.

Genus *NOTOPEPLUM* Finlay, 1927

1927 *Notopeplum* Finlay, *Trans. N.Z Inst.*, 57: 514. Type species (original designation): *Scaphella victoriensis* Cossmann, 1899, [= *Voluta polita* Tate, 1889].

Distribution: Recorded living on the continental shelf of southern and south western Australia from South Australia to the Fremantle region, Western Australia at depths from 12 to 200 metres. Fossil species are known from Miocene sediments of Victoria and Tasmania.

Remarks: Until now the southern Australian volute *N. translucidum* (Verco, 1896) was the only Recent species of *Notopeplum* known, and that only from a few "dead" shells. There are four described fossil species in the Tertiary (Miocene) sediments of south eastern Australia (pers. comm. Mr T. A. Darragh) viz. *N. polita* (Tate, 1889) (= *victoriensis* Cossmann, 1899); *N. balcombensis* Finlay, 1930 (= *maccoyi* Tate, 1889, *non* Ten. Woods, 1877); *N. maccoyi* (Ten. Woods, 1877); *N. protorhysum* (Tate, 1889). In addition Mr Darragh advises me that there is a fifth fossil species which is unnamed.

All five fossil species, and *N. translucidum* are characterized by rather small, elongate-ovate, very thin, smooth shells, which have a smooth, broad, dome-shaped, and often slightly deviated protoconch of only about $1\frac{1}{2}$ whorls. The protoconch is not sharply differentiated in any way from the teleoconch whorls. Often the second teleoconch whorl encroaches upon the first. There are 4 oblique columellar plaits, a rather shallow anterior canal, and shoulders and anterior fasciole are weak or lacking.

N. translucidum is said to have a thin deciduous white periostracum (Weaver & du Pont, 1970: 170).

Although these species form an easily distinguishable generic group on shell characters their relationship to other genera is uncertain. The discovery of another living species is, therefore, of special interest. The observations on the new species reported below suggest that the position of *Notopeplum* in the subfamily Scaphellinae (see Weaver and du Pont, 1970) may need reconsideration in favour of the Fulgorarinae. Comparable anatomical data on Australian Fulgorarinae and Scaphellinae are much needed.

Notopeplum annulatum sp. nov.

Pl. 33, fig. 1 - 4.

Type locality: CSIRO station 225; 32°00'S : 115°16'E; W of Rottnest Island, W.A.; 141 — 146 m, with modest catch of fish and shells, no sponges, bottom water temp. 17.74°C.

Type series. Holotype: A "dead" adult shell taken with a hermit crab in a beam trawl by CSIRO aboard HMAS "Diamantina," cruise DM 6/63, 12th Oct. 1963, WAM.132-64.

Paratypes: 1. One sub-adult specimen with body preserved, radula mounted, shell with lip not fully formed and slightly broken; from same locality and trawl haul as the holotype; WAM. 134-64. 2. One "dead" juvenile shell, from CSIRO station 144, 32°00'S : 115°08'E, W of Rottnest Island, HMAS "Diamantina" cruise DM 4/63, 28th Aug. 1963; 141 m; beam trawl with starfish, sponge and bryozoa; WAM. 472-71.

There is also a fragment not designated as a paratype from NW of Rottnest Island, 156 m; dredged, with sponges; B. R. Wilson on "Bluefin", 15th Aug. 1962; WAM cat. no. N4355.

Description of the holotype: Shell fusiform, with a total of 6 whorls, thin and translucent, surface very smooth and glossy, lacking sculpture of any kind. Spire high, spire height to total shell height ratio 0.41. Protoconch smooth, opaque, glassy, calloused, slightly deviated, broad and dome-shaped, not sharply differentiated from teleoconch so that number of protoconch whorls is not determinable. Second whorl with a diagonal flaw resembling a suture line. Coiling normal except for a difference of about 15° between the suture slopes of the first-second and second-third whorls (Pl. 33, fig. 4). Whorls convex, lacking shoulders, sutures weakly incised. Outer lip convex, slightly flared out anteriorly, columellar and parietal walls gently curved, aperture widens anteriorly. Columella weak, not calloused, bearing 4 oblique plaits of which the central two are moderately strong, straight sided and flat topped, the posterior one is weak and bifid, and the anterior one is moderately strong and forms the almost axial lip of the anterior part of the columella. Anterior canal broad, moderately deep; anterior fasciole weak. Early whorls cream merging into fawn to

PLATE 33.

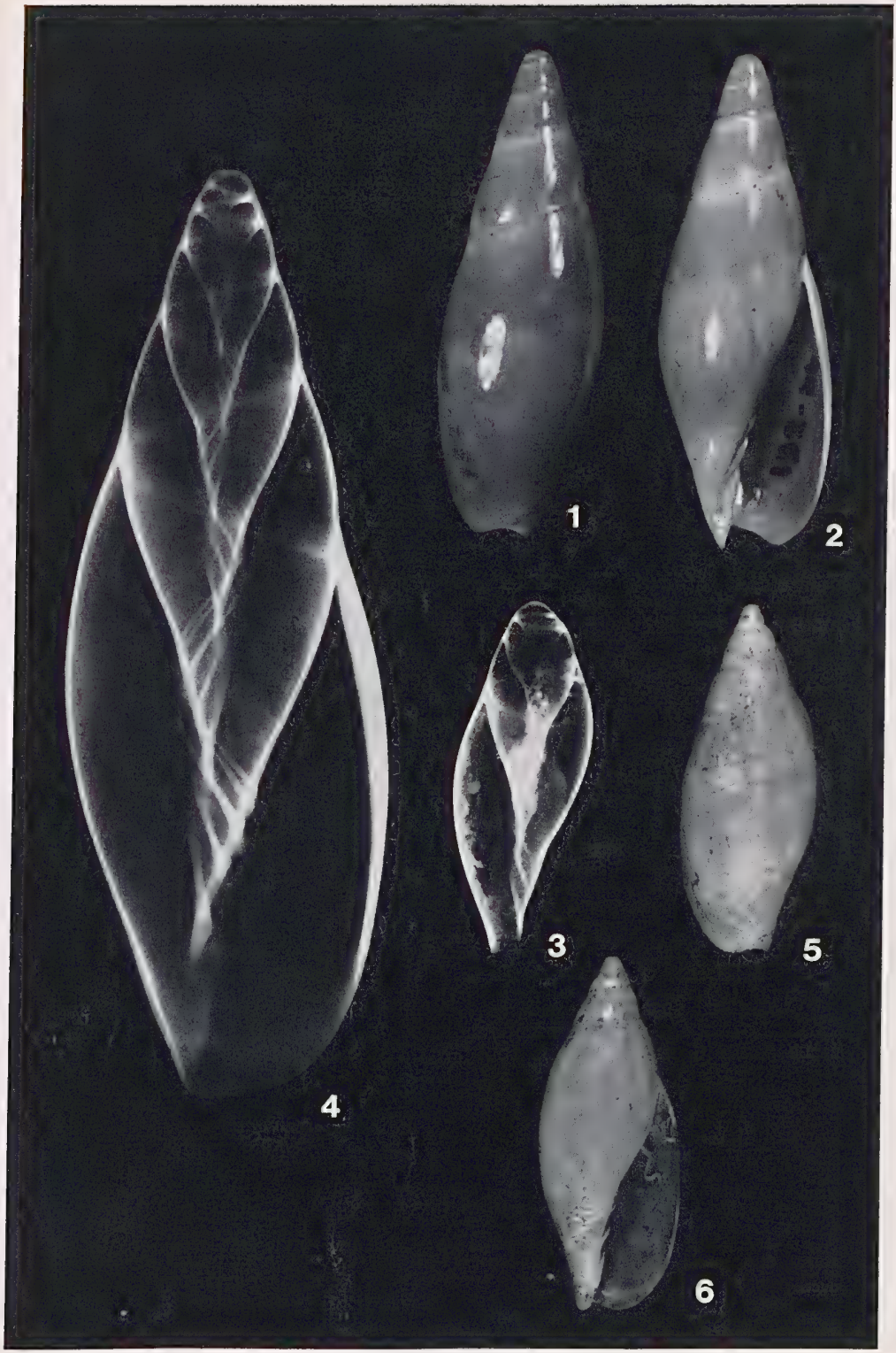
Fig. 1-2. *Notopeplum annulatum* sp. nov., Holotype; WAM.132-64, west of Rottnest I., W.A., 141-146 m.

Fig. 3. *Notopeplum annulatum* sp. nov., Paratype; juvenile, WAM.472-71, X-ray, west of Rottnest I., W.A., 137 m.

Fig. 4. *Notopeplum annulatum* sp. nov., Holotype; WAM.132-64, X-ray.

Fig. 5-6. *Notopeplum translucidum* (Verco, 1896), Holotype; S.A.M. Reg. No. 13614, Newlands Head, 36 m.

Figures 1 - 3, 5 - 6 approximately x 1½, Figure 4 x 3.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apricot on the later whorls. Body whorl with a wide pale central spiral band bordered by two poorly defined thick white spiral lines on each side, and with another thick white spiral line below the suture. Small regularly spaced orange-brown rings enclosing pale orange spots lie on the two central white lines; confluent orange brown blotches lie on the subsutural line. The most posterior of the central lines and its rings are evident above the sutures of the 4th and 5th whorls. Columellar teeth white, anterior fasciole off-white, lip margin white, interior takes the colour of the exterior although the spiral lines and rings do not show through. Measurements: total shell height 53.4 mm, spire height 21.9 mm, width 20.2 mm.

Anatomy (of Paratype 1, WAM.134-64): Foot and head of a rose ground colour, with large, approximately round pale yellowish green blotches encircled by rings of small, round white spots at their peripheries and containing numerous irregular, smaller white spots in their centres, and with numerous round white spots of varying size on the rose ground colour between the yellowish green blotches. Tentacles and siphon pale green to white with blotches of dark rose.

Head typically volutid, with 3 flap-like lobes, the central one undivided and separated from the lateral lobes by the tentacles which are of moderate length and blunt in the preserved specimen but longer and attenuated in a photograph of the same specimen when alive. Eyes small, located on the edge of the lateral head lobes adjacent to the tentacles. Siphon with a pair of flat, square-ended lateral lobes of approx. equal size. Foot lacking metapodial lobes, anterior part of foot more densely pigmented than remainder and demarcated from it by a shallow marginal indentation on each side; anterior pedal groove present around the entire margin of the anterior part of the foot. Penis tubular not grooved, crescent-shaped with a short terminal "spike", sperm duct closed and terminates proximally in a spongy glandular organ, presumably prostate, at the back of the mantle cavity behind the hypobranchial gland. Arrangement of mantle cavity organs otherwise typical for the family (see Clench & Turner, 1964, p. 133, Pl. 81).

Oesophagus wide and lying medially over the buccal mass which it totally obscures from above. Accessory salivary glands long, convoluted, and lie over the rather compact salivary glands (the "racemose salivary glands" of Clench & Turner, 1964) which are thus partially obscured; both pairs of salivary glands loosely bound together with connective tissue and lie over the nerve ring. Ducts of both pairs of salivary glands were not followed beyond their junction with the oesophagus.

Unpaired fore-gut gland (see Hyman, 1967: 221) consists of two distinct parts; the anterior part is a compact, rather solid, roughly spherical mass situated on top of the oesophagus just behind the nerve ring; the

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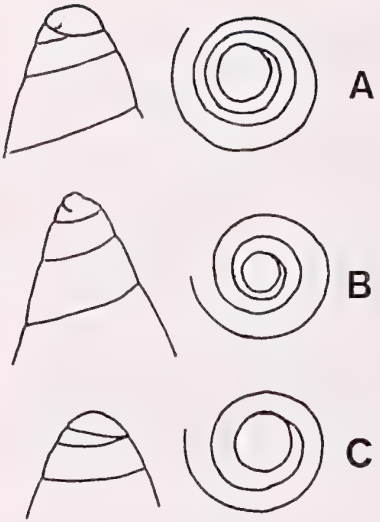
Fig. A, *Notopeplum annulatum* sp. nov. Holotype protoconch, WAM.132-64. B, *Notopeplum annulatum* sp. nov. Paratype protoconch, WAM.134-64. C, *Notopeplum politum* Tate, 1889. Holotype protoconch (drawing by courtesy Dr N. Ludbrook). D, *Notopeplum annulatum* sp. nov. Radula tooth of paratype, WAM.134-64. E, *Amoria diamantina* sp. nov. Radula tooth of a panatype, WAM. 626-71. F, *Notopeplum annulatum* sp. nov. Paratype WAM.134-64: Living animal drawn from a colour slide. G, *Notopeplum annulatum* sp. nov. Paratype WAM.134-64: Organs of the anterior digestive system. 1 — Proboscis, 2 — Oesophagus, 3 — Accessory salivary gland, 4 — Duct of salivary gland, 5 — Salivary gland, 6 — Nerve ring, 7 — Anterior part of un-paired fore-gut gland, 8 — Posterior part of un-paired fore-gut gland (Gland of Leiblein). H, *Notopeplum annulatum* sp. nov. Paratype WAM.134-64: External morphology of the anterior part of the body drawn from the preserved specimen. 1 — Basal lobe of siphon, 2 — Siphon, 3 — Central head lobe, 4 — Proboscis, 5 — Eye stalk, 6 — Transverse anterior pedal groove, 7 — Lateral head lobe, 8 — Penis, 9 — Seminal duct.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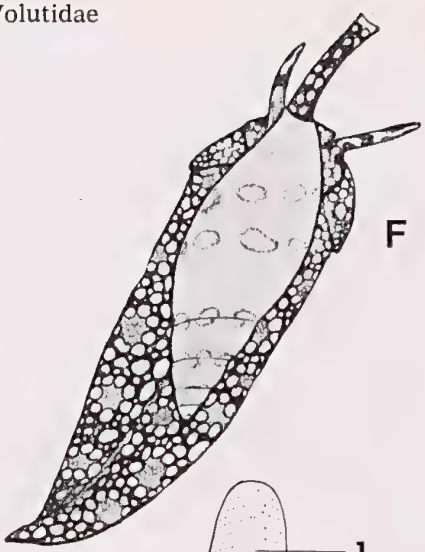
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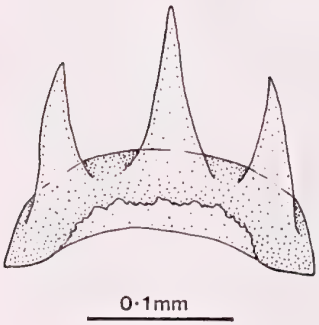
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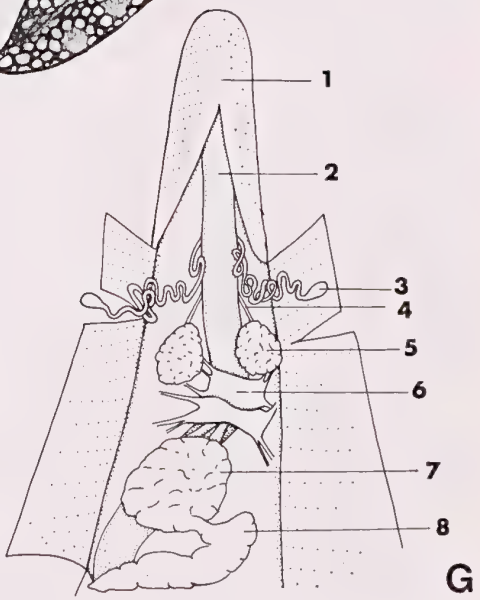
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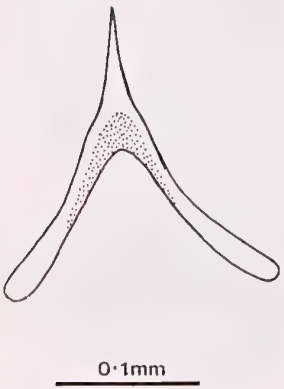
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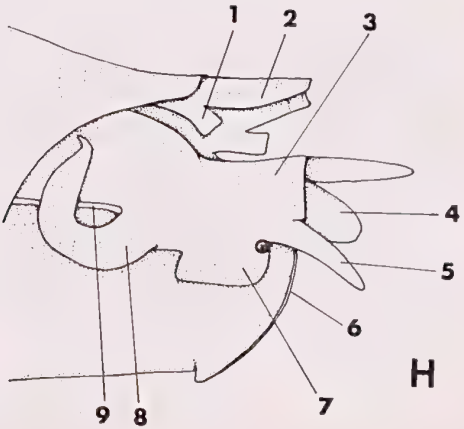
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posterior part, the Gland of Leiblein, is a large, rather solid, lobulate sac which is not bound by connective tissue within the anterior mass.

Nervous system, vascular system, internal reproductive system, and the mid and hind parts of the alimentary system not examined.

Radula: Uniserial; teeth tricuspid; central cusp narrow, attenuate, with slightly concave sides; lateral cusps slightly shorter than the central cusp, attenuate, with concave inner and convex outer sides, base broad and shaped like a very wide and shallow, inverted U. (Text fig. 1D).

Remarks: The extremely high gloss, delicate colour, and spiral rows of orange-brown circles, render the shell of this species striking and unusual. There is no living species known to me with which it could be confused. That it belongs to the genus *Notopeplum* seems assured by the thin, smooth shell and the broad, heavily calloused, dome-shaped protoconch of few whorls. Apart from its unique colour pattern, *N. annulatum* differs from the only other known living species of the genus, *N. translucidum*, in its more elongate, slightly fusiform shell with higher spire and less convex whorls. The aperture is less ovate and wider at the anterior end, and the columellar plaits are weak.

Of particular interest is the variation in the protoconch within the type series. From the X-rays (Pl. 33, figs. 3-4) it appears that in some specimens (e.g. the holotype) there is a change in the rate of descent between the protoconch whorl and what is taken to be the first teleoconch whorl. The results are that there is a change in the slopes of the sutures between the first-second and second-third whorls, and the second teleoconch whorl encroaches over the first (Pl. 33, fig. 4). This gives the impression that the protoconch is slightly deviated. In other specimens (e.g. paratype 2, WAM. 472-71) the change in rate of descent is less, the second teleoconch whorl does not encroach markedly upon the first, and the protoconch is not deviated (Pl. 33, fig. 3). It is curious to note that similar protoconch variation occurs in the fossil species *N. polita.*

Having only one preserved specimen to dissect, the anatomical observations made on this species are incomplete. Special attention was paid to the organs of the anterior digestive system for these provided the characters used by Clench and Turner (1964) for their grouping of genera into subfamilies. Several features are worthy of note.

The "fluffy" salivary glands and the accessory salivary glands are not bound together by connective tissue and in this condition the species resembles the Scaphellinae and Volutinae (see Clench and Turner, 1964). The gland of Leiblein also resembles the condition described in the Scaphellinae by Clench and Turner. On the other hand, there are two siphonal lobes of equal size in *N. annulatum* while Clench and Turner (1964) state that there is only a single basal lobe on the left side of the siphon in the species of Scaphellinae which they examined. (But note that there are two equal lobes in the genus *Amoria* which is also at present placed in Scaphellinae.) The radula resembles that of *Ericusa* (Fulgorarinae) in having a broad base and a prominent pointed cusp on each side of the central cusp

The only conclusion to be made is that *N. annulatum* has some anatomical characters which ally it to the subfamily Scaphellinae but others which do not. Much more anatomical work is needed on Australian volutes before generic affinities of this and other groups can be properly assessed.

ACKNOWLEDGEMENTS

I am most grateful to Dr D. F. McMichael who first drew my attention to the fact that the species described here were new and later made many helpful suggestions and criticisms. Special thanks are also due to Mr T. Darragh and Dr N. Ludbrook who freely gave information on fossil species, together with their stimulating ideas and observations on the evolution and palaeogeography of the southern Australian Tertiary and Recent faunas. Dr Winston Ponder made helpful comments on the manuscript, especially regarding the anatomical observations. Mr Frank Abbottsmith's remarks were also helpful. Mrs Shirley Slack-Smith gave much assistance in reading the manuscript and selecting the species' names. Miss Anne Paterson assisted with the photography. The X-ray photographs were taken by Mr H. Klavins through the courtesy of Mr R. Plummer at Sir Charles Gairdner Hospital, W.A. Dr Graham Chittleborough and Mr Barry Scott of C.S.I.R.O. collected many of the specimens taken during oceanographic cruises of H.M.A.S. "Diamantina" and their cooperation is greatly appreciated.

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